

CLAIMS

We claim:

1. A method for evaluating a feature, comprising:
receiving an image of the feature;
determining respective coordinates of a plurality of points on an edge of the feature in the image;
fitting a figure having a non-circular non-linear shape to the plurality of points;
determining respective distances between the plurality of points and the figure;
and
computing a roughness parameter for the feature in response to the respective distances.
2. The method according to claim 1, wherein computing the roughness parameter comprises computing a contact edge roughness (CER) in response to a sum of the squares of the respective distances and a number of degrees of freedom of the figure.
3. The method according to claim 1, wherein computing the roughness parameter comprises computing a correlation length (CL) in response to a sum of the squares of the respective distances, a number of degrees of freedom of the figure, and an average of squares of differences of the respective distances.
4. The method according to claim 1, wherein computing the roughness parameter comprises performing a Fourier analysis of the respective distances, and generating a power spectrum in response to the analysis.
5. The method according to claim 4, wherein generating the power spectrum comprises filtering results of the Fourier analysis.
6. The method according to claim 5, wherein filtering the results comprises selecting a filter in response to a process used to form the feature.

7. The method according to claim 1, wherein the feature is formed on a substrate, and wherein the feature and the substrate are comprised in a semiconductor wafer.
8. The method according to claim 7, wherein the feature comprises a contact hole.
9. The method according to claim 1, wherein receiving the image comprises generating the image with a scanning electron microscope.
10. The method according to claim 1, wherein the figure comprises an ellipse.
11. The method according to claim 1, wherein the figure has a known shape.
12. The method according to claim 1, wherein fitting the figure comprises determining a nominal shape of the figure by averaging at least some of the plurality of the points.
13. The method according to claim 1, wherein the figure is selected from a closed figure and an open figure.
14. The method according to claim 1, wherein the distance is chosen from a perpendicular distance and a radial distance.
15. The method according to claim 1, wherein the feature is chosen from a reticle, a part of the reticle, and a cast of a structure.
16. A method for evaluating a feature, comprising:
 - receiving an image of the feature;
 - determining respective coordinates of a first plurality of points on a first edge of the feature in the image;
 - fitting a first figure having a first non-circular non-linear shape to the first plurality of points;
 - determining respective coordinates of a second plurality of points on a second edge of the feature in the image;

fitting a second figure having a second non-circular non-linear shape to the second plurality of points;

determining respective distances between the first and the second figures; and

computing a roughness parameter for the feature in response to the respective distances.

17. Apparatus for evaluating a feature, comprising:

an imaging unit which is adapted to generate an image including the feature; and

a processor which is adapted to:

determine respective coordinates of a plurality of points on an edge of the feature in the image,

fit a figure having a non-circular non-linear shape to the plurality of points,

determine respective distances between the plurality of points and the figure, and

compute a roughness parameter for the feature in response to the respective distances.

18. The apparatus according to claim 17, wherein computing the roughness parameter comprises computing a contact edge roughness (CER) in response to a sum of the squares of the respective distances and a number of degrees of freedom of the figure.

19. The apparatus according to claim 17, wherein computing the roughness parameter comprises computing a correlation length (CL) in response to a sum of the squares of the respective distances, a number of degrees of freedom of the figure, and an average of squares of differences of the respective distances.

20. The apparatus according to claim 17, wherein computing the roughness parameter comprises performing a Fourier analysis of the respective distances, and wherein the processor is adapted to generate a power spectrum in response to the analysis.

21. The apparatus according to claim 20, wherein generating the power spectrum comprises filtering results of the Fourier analysis.
22. The apparatus according to claim 21, wherein filtering the results comprises selecting a filter in response to a process used to form the feature.
23. The apparatus according to claim 17, wherein the feature is formed on a substrate and wherein the substrate and the feature are comprised in a semiconductor wafer.
24. The apparatus according to claim 23, wherein the feature comprises a contact hole.
25. The apparatus according to claim 17, wherein the imaging unit and the processor are comprised in a scanning electron microscope.
26. The apparatus according to claim 17, wherein the figure comprises an ellipse.
27. The apparatus according to claim 17, wherein the figure has a known shape.
28. The apparatus according to claim 17, wherein the processor is adapted to determine a nominal shape of the figure by averaging at least some of the plurality of the points.
29. The apparatus according to claim 17, wherein the figure is selected from a closed figure and an open figure.
30. The apparatus according to claim 17, wherein the distance is chosen from a perpendicular distance and a radial distance.
31. The apparatus according to claim 17, wherein the feature is chosen from a reticle, a part of the reticle, and a cast of a structure.
32. Apparatus for evaluating a feature, comprising:
an imaging unit which is adapted to generate an image including the feature; and

a processor which is adapted to:

- determine respective coordinates of a first plurality of points on a first edge of the feature in the image,
- fit a first figure having a first non-circular non-linear shape to the first plurality of points,
- determine respective coordinates of a second plurality of points on a second edge of the feature in the image,
- fit a second figure having a second non-circular non-linear shape to the second plurality of points,
- determine respective distances between the first and the second figures, and
- compute a roughness parameter for the feature in response to the respective distances.

33. A method for evaluating a feature, comprising:

- receiving an image of the feature;
- determining respective coordinates of a plurality of points on an edge of the feature in the image;
- fitting a figure to the plurality of points;
- determining respective distances between the plurality of points and the figure;

and

- computing a correlation length in response to a sum of the squares of the respective distances, a number of degrees of freedom of the figure, and an average of squares of differences of the respective distances.

34. A method for evaluating a feature, comprising:

- receiving an image of the feature;
- determining respective coordinates of a plurality of points on an edge of the feature in the image;
- fitting a figure to the plurality of points;
- determining respective distances between the plurality of points and the figure;

performing a Fourier analysis of the respective distances; and
filtering results of the Fourier analysis in response to a process used to form the feature.

35. A method for evaluating a feature, comprising:
receiving an image of the feature;
determining respective coordinates of a plurality of points on an edge of the feature in the image;
fitting a figure to the plurality of points;
determining respective distances between the plurality of points and the figure;
performing a Fourier analysis of the respective distances; and
filtering results of the Fourier analysis in response to a shape of the feature.
36. Apparatus for evaluating a feature, comprising:
an imaging unit which is adapted to generate an image including the feature; and
a processor which is adapted to:
determine respective coordinates of a plurality of points on an edge of the feature in the image,
fit a figure to the plurality of points,
determine respective distances between the plurality of points and the figure, and
compute a correlation length in response to a sum of the squares of the respective distances, a number of degrees of freedom of the figure, and an average of squares of differences of the respective distances.
37. Apparatus for evaluating a feature, comprising:
an imaging unit which is adapted to generate an image including the feature; and
a processor which is adapted to:
determine respective coordinates of a plurality of points on an edge of the feature in the image,
fit a figure to the plurality of points,
determine respective distances between the plurality of points and the figure,

perform a Fourier analysis of the respective distances, and
filter results of the Fourier analysis in response to a process used to form the
feature.

38. Apparatus for evaluating a feature, comprising:
an imaging unit which is adapted to generate an image including the feature; and
a processor which is adapted to:
determine respective coordinates of a plurality of points on an edge of the feature
in the image,
fit a figure to the plurality of points,
determine respective distances between the plurality of points and the figure,
perform a Fourier analysis of the respective distances, and
filter results of the Fourier analysis in response to a shape of the feature.